United States Patent

McCarthy

[15] 3,660,121

[45] May 2, 1972

[54] HOT TOP LINER AND REFRACTORY RING COMBINATION FOR USE WITH METAL HOT TOP CASING

[72] Inventor: **James F. McCarthy,** Mars, Pa.

[73] Assignee: **The Susquehanna Corporation,** Fairfax, Va.

[22] Filed: **Feb. 5, 1970**

[21] Appl. No.: **9,083**

[52] **U.S. Cl.**.....**106/38.25,** 106/38.22, 249/197, 249/202, 260/29.3, 260/38, 260/39 SB

[51] **Int. Cl.**.....**B28b 7/36**

[58] **Field of Search** .....106/38.22, 38.23, 38.24, 38.27, 106/38.25; 249/197, 201, 202; 260/DIG. 40, 38, 39 SB, 29.3

[56] **References Cited**

UNITED STATES PATENTS

3,072,981	1/1963	Davidson	106/38.35 X
3,297,296	1/1967	Edstrom et al.	249/197
3,478,999	11/1969	Charman et al.	249/201

Primary Examiner—Lorenzo B. Hayes

Attorney—Eugene F. Buell

[57] **ABSTRACT**

A combination of an exothermic insulting fiber and refractory ring for use in a metal hot top casing. The liner composition comprises by weight from 7–10 percent asbestos, from 7–12 percent wood flour, from 41–51 percent sand, from 26–32 percent silica flour and from 5–8 percent resin binder; and the refractory ring composition comprises by weight from 4.5–5.5 percent low water content asbestos, from 4.5–5.5 percent high water content asbestos, from 84–87 percent sand and from 4.5–6 percent resin binder.

11 Claims, No Drawings

HOT TOP LINER AND REFRACTORY RING COMBINATION FOR USE WITH METAL HOT TOP CASING

BACKGROUND OF THE INVENTION

This invention relates to a combination of a hot top liner and a refractory ring, and the composition for each, for use in a metal hot top casing.

As is well understood in the art, hot top casings are used in conjunction with ingot molds in the casting of metal ingots such as steel ingots. The purpose of these hot tops is to provide a reservoir of molten metal in the casing to feed the pipe or shrinkage cavity in the ingot mold as it tends to form during solidification. In this manner, solid or non-porous ingots can be produced without the necessity of scrapping a portion of the ingot from the mold and only the top portion containing a minor amount of steel must be cropped.

The latest type of hot top casing in commercial use today for the casting of big end up ingots comprises a metal casing, generally a one-piece casing, having an insulating or exothermic liner on the inner surface of the casing and a refractory ring around the bottom of the casing. The hot top casing itself is reuseable but the insulating liner and refractory ring must be replaced after each use, that is, after the casting of each ingot. The liner and refractory ring are made generally from relatively low cost compositions having good heat insulation or exothermic properties, and the compositions for the liner and the refractory ring are usually preformed into self-supporting slabs or sleeves for the liner and into rings to fit a particular casing with which they are to be used. After each use of a hot top casing, the remnants of a used liner and refractory ring, which are at least partially disintegrated during the casting operation, are removed from the metal casing and replaced by a new liner and refractory ring so that a casing is ready for use in a subsequent ingot pouring operation.

Many compositions have been proposed for hot top liners to overcome the characteristic difficulties of prior art materials which include insufficient insulating capacity, contamination of the ingot, and others. Also, many of the premolded insulating materials or liners which are inserted in the casings as insulating surfaces are very fragile and readily broken. In this instance, damage results to the casing by contact of the molten metal.

To perform most satisfactorily, insulating liners should have good resistance to breakage at ambient temperatures to permit good storage and handling; should have a measure of deformability to permit use in non-uniform casings; should have good insulating and a measure of exothermic properties to permit minimum heat loss from the reservoir of molten metal; should break down or lose structural integrity after use without contaminating a poured ingot to permit easy removal from an ingot and casing, and should be a low cost item to permit economy of operation.

Many compositions have been proposed for refractory rings to overcome the characteristic difficulties of prior art materials such as cracking or breaking and failure of a ring to protect a hot top casing from contact with molten metal and failure to seal the molten metal to the ingot mold wall at the top of the mold. When a refractory ring is prepared having a thermal conductivity which is too low, the molten metal in an ingot mold will not seal off rapidly enough at the top of the mold around the ring, and then molten metal will pass the ring causing failure of the casting by welding the metal hot top casing to the ingot or ingot mold. When the thermal conductivity of a refractory ring is too high, the molten metal may be cooled during the pour too rapidly at the throat or top portion of the ingot mold causing the throat section to seal off. This prevents the reservoir of molten metal in the hot top casing from feeding the solidifying metal in the ingot mold causing sink holes or pores in the ingot and unnecessary ingot loss in the casting operation.

The problems involved in preparing proper compositions for hot top liners and refractory rings, which will perform their desired functions more than adequately, result from at least two things. It has been recognized that the hot top liners and the refractory rings perform separate and individual functions, and accordingly, compositions were prepared for each to meet the requirements of the function of each. It has not been recognized, however, that a liner and a refractory ring must also perform as a unit to carry out their individual functions properly.

A hot top liner and a refractory ring are generally in contact with each other when they are assembled to a metal hot top casing and failure of one will cause the failure of both in the production of a good ingot or the protection of a metal casing. Also, each must supply insulating and exothermic properties to the molten metal during the pouring and its subsequent freezing; and if the proper amount of insulating and exothermic properties are not supplied by each, then again the ingot, the ingot mold or the hot top casing or all three may be a loss.

It is clear, therefore, that a combination of a hot top liner and a refractory ring which are tailored in their insulating and exothermic properties to be used successfully as a combination with a metal hot top casing for big end up ingot molds is a worthwhile advance in the art.

SUMMARY OF THE INVENTION

In accordance with this invention, there is provided a new and novel combination of a hot top liner and refractory ring for use with a metal hot top casing comprising, in combination, a hot top liner having a composition by weight consisting essentially of:

a. from about 7 to about 10 percent asbestos;
b. from about 7 to about 12 percent wood flour;
c. from about 41 to about 51 percent sand;
d. from about 26 to about 32 percent silica flour; and
e. from about 5 to about 8 percent of a resin binder;

and a refractory ring having a composition by weight consisting essentially of:

f. from about 4.5 to about 5.5 percent water content asbestos;
g. from about 4.5 to about 5.5 percent high water content asbestos;
h. from about 84 to about 87 percent sand; and
i. from about 4.5 to about 6 percent of a resin binder.

Other embodiments of the invention are the combination as described further characterized by the low water content asbestos being amosite asbestos and/or the high water content asbestos being chrysotile asbestos.

Another embodiment of the invention is a combination of hot top liner and refractory ring as defined further characterized by the sand for the hot top liner composition having an American Foundry Standard grain fineness number of about 110.

Another embodiment of the invention is the combination as defined further characterized by the sand for the refractory ring composition having an A.F.S. grain fineness number of about 110.

Another embodiment of the invention is the combination as defined further characterized by the silica flour having a particle size smaller than about 200 mesh.

Still another embodiment of the invention is the composition as defined further characterized by the asbestos for the hot top liner composition being amosite asbestos.

The combination of hot top liner and refractory ring of this invention has many advantages. The individual parts, or the liner and the refractory ring, have considerable deformability and resilience at ordinary temperatures which provide excellent resistance to breakage and damage during handling and storage. When the combination of hot top liner and refractory ring is used in a hot top casing, no damage results to the hot metal casing, the ingot or the ingot mold from any failure of the liner or the refractory ring to function properly. In use in a casing during a pouring operation, the hot top liner provides good insulating characteristics and sufficient exotherm to

maintain the needed reservoir of molten metal within the hot top casing to provide good ingots free from porosity; and the refractory ring has the required amount of thermal conductivity and exotherm to prevent cracking and breaking of the ring; to provide a metal seal at the right rate without permitting welding of the hot top casing to the head of the mold; and there is no metal freezing within the throat of the ingot preventing proper filling of the ingot from the hot top reservoir. When using the combination of hot top liner and refractory ring of this invention, the overall design of the hot top casing can be changed to reduce the area of the opening into the ingot mold from the usual 50 percent of throat opening to 40 percent or less; and ingot loss due to cropping of the solidified material within the hot top casing is 7 percent or less.

DESCRIPTION OF PREFERRED EMBODIMENTS

In the combination of this invention, the hot top liner and the refractory ring may be a one-piece structure or a multi-piece structure depending upon the design and shape of the hot top casing with which they may be used. In general, a refractory ring is a molded one-piece article and a hot top liner may be molded panels which are inserted separately within the hot top casing or a molded group of panels which are hinged by wire, paper or other means so that it can be stored flat and made into a proper rectangular or other shaped structure for insertion within the hot top casing. One-piece liners molded into a desired shape are known and used also.

The combination of this invention of a hot top liner and a refractory ring is for use in metal hot top casings without insulating firebrick linings; however, the combination would find utility in lined casings also. The combination of this invention may be used in the more common one-piece or multi-piece metal hot top casing; and in certain applications, a hot top liner or refractory ring may be used separately with good success in hot top casings.

The hot top liner of this invention is one having a composition by weight consisting essentially of:

a. from about 7 to about 10 percent asbestos;
b. from about 7 to about 12 percent wood flour, preferably about 8 to 11 percent;
c. from about 41 to about 51 percent sand;
d. from about 26 to about 32 percent silica flour; and
e. from about 5 to about 8 percent of a resin binder.

In this tailored formulation for a hot top liner to be used in combination with a tailored ring, it is important to have present both the wood flour and the silica flour to provide excellent insulating characteristics, high density for the panel with good porosity for easy molding or formation and good exotherm which is necessary especially when cold hot top casings are used in an ingot pouring operation.

The asbestos for the hot top liner composition may be any of the well-known asbestos having either high or low water content or mixtures thereof, such as amosite, chrysotile or others. In accordance with this invention, it is preferred that the asbestos for the hot top liner be amosite asbestos because of its availability and economy, and the high strength it provides at this generally reduced asbestos content.

The asbestos fibers for both the low and high water content materials may be of substantially any length, and any of the shorter length materials which are more economical may be used. The fibers used, however, should be sufficiently long to provide strength to the structure.

The wood flour of the composition may be any softwood flour or hardwood flour, or mixtures thereof, that is readily available. It is preferred that the wood flour have a particle size no larger than about 35 mesh, preferably about 40 mesh; and when hardwood flour is used, concentrations in the higher percentages are preferred, and preferably about 10–11 percent. Softwood flour is preferably used in the lower percent ranges, and preferably about 8–10 percent. Softwood flour is preferred.

The sand used in the liner composition may be of substantially any particle size or mixture of particle sizes readily available; however, it is preferred that the sand for the hot top panel composition have an A.F.S. grain fineness number of from about 75 to about 200, and of these, a grain fineness number of about 110 is more preferred.

The silica flour used in the liner composition may be of any of the readily available silica flours and it is preferred in accordance with this invention that the silica flour have a particle size smaller than about 200 mesh.

The silica flour, which is amorphous, as distinguished from the sand, which is crystalline, provides improved insulation properties. The sand provides improved processing properties in terms of more rapid filtration, faster drying and faster cure than would be obtained with the amorphous silica flour alone.

The resin binder of this invention may be any of the inexpensive readily available resin binders which are thermosetting such as ureaformaldehyde, phenolformaldehyde resins and others from which an aqueous or solvent dispersion may be prepared. Thermoplastic resins from which dispersions may be prepared and which have good high temperature resistance may be used also. In accordance with this invention, it is preferred that a phenolformaldehyde resin binder be used.

The refractory ring of the combination of this invention is one having a composition by weight consisting essentially of:

a. from about 4.5 to about 5.5 percent low water content asbestos;
b. from about 4.5 to about 5.5 percent high water content asbestos;
c. from about 84 to about 87 percent sand; and
d. from about 4.5 to about 6 percent of a resin binder.

Although not understood completely, it is important that a combination of low water content and high water content asbestos be present in the refractory ring composition. It is thought that the additional moisture content of the asbestos, as well as the high strength of the high water content asbestos at elevated temperature, causes the refractory ring to have good strength and seal well in the ingot mold during burn-out of the generally high resin content of the refractory ring. Stated in another manner, because the refractory ring is used generally with cold casings, a measure of exotherm is necessary to prevent freezing of the molten metal across the throat of the mold and this exotherm is supplied at least in part by the resin binder. The combination of asbestos fibers provides desired strength to the refractory ring during the burn-out of this resin so that the composition performs more than adequately in preventing freezing of the molten metal at the throat of the mold as well as maintaining integrity to the ring to seal the metal from the mold wall and prevent welding of the hot top casing to the head of the mold.

Low water content asbestos materials generally have a combined water content of from about 3 to about 6 percent, and amosite, tremolite, crocidolite and anthrophyllite asbestos materials, as well as mixtures of these and other materials, are representative of low water content asbestos. Of these, the use of amosite asbestos for the low water content asbestos is preferred. High water content asbestos materials generally have a combined water content of from about 12 to about 18 percent and chrysotile asbestos materials, as well as mixtures of these and other materials, are representative of high water content asbestos.

The sand for the refractory ring may be of any of the readily available sands having varying compositions of particle size and concentrations of particle size; however, it is preferred in accordance with this invention that the sand for the refractory ring composition have an A.F.S. grain fineness number of from about 75 to about 200, and of these, a grain fineness number of about 110 is more preferred.

The thermosetting resin binder for the refractory ring may be any of the resin binders described previously for the liner composition; and of these it is preferred that the resin binder be a phenolformaldehyde resin capable of being prepared in dispersion form.

The hot top liners and refractory rings of this invention may be prepared in any manner well-known for the preparation of similar articles. In general, a water slurry of the components of the composition are prepared using a large excess of water, and then the slurry is laid down on a screen or other porous mold which has been shaped to define a desired liner or ring configuration. Following this, excess water is removed from the article by vacuum or pressure and the partially dried article within the mold is subjected to heat at a temperature of from about 250° to 400° F., preferably about 350° to 390° F., for a period of time sufficient to dry the panel and to cure the resin binder. Other suitable curing methods may be used for the resin binder also. After this, the dry liner or ring may be stored for shipment or use as needed.

A hot top liner was prepared in accordance with this invention by mixing a weight percent composition of 8.4 percent amosite asbestos fibers, 9.4 percent hardwood flour, 46.7 percent sand having an A.F.S. grain fineness number of about 110, 29 percent silica flour having a particle size smaller than about 200 mesh and 6.5 percent of a phenolformaldehyde resin in a suitable container with an excess of water to prepare a slurry. Following this, the slurry was passed into a flat screen mold prepared in the proper shape to make a liner having jointed panels approximately 2 feet long, 8 inches wide and 1 inch thick. Excess water was removed from the mold by pressure and the joined panels cured in an oven at a temperature of from about 350° to 390° F. for a period of about 2 hours. The hot top liner having joined panels was removed from the oven and mold after curing of the binder was substantially complete.

A refractory ring was prepared in accordance with this invention by mixing a weight percent composition of 85.7 percent sand having an A.F.S. number of 110, 4.7 percent amosite asbestos fibers, 4.8 percent chrysotile asbestos fibers, and 4.8 percent phenolformaldehyde resin with water to form a slurry. The slurry was molded in the same fashion as the liner to prepare a refractory ring to fit the bottom portion of a metal hot top casing and overlap the bottom edge of the molded hot top liner when inserted in the casing.

When the liner is inserted in a metal hot top casing having a temperature of approximately 80° F. and the refractory ring is placed on the bottom portion of the casing and held there with clips, the inner surface of the hot top casing is covered completely and the ring covers the bottom edge of the casing and inserted liner and extends approximately 2 inches beyond the outside of the casing. When the assembled hot top casing is placed on the top of a big-end-up ingot mold, the opening in the hot top casing is approximately 40 percent of the throat opening of the ingot mold; and when a steel ingot is poured, a good metal seal is obtained between the ring and the ingot mold and the hot top feeds the ingot. The used casing strips easily from the ingot and the remnants of the liner strip easily from the casing and ingot. It is necessary to crop approximately 7 percent of the steel of the resulting solidified ingot to produce a good ingot free from pores and sinkholes.

We claim:

1. A combination of a hot top liner and a refractory ring for use with a metal hot top casing comprising, in combination, a hot top liner having a composition by weight consisting essentially of:
   a. from about 7 to about 10 percent asbestos;
   b. from about 7 to about 12 percent wood flour, selected from the group consisting of softwood flour, hardwood flour, and mixtures thereof;
   c. from about 41 to about 51 percent sand;
   d. from about 26 to about 32 percent silica flour; and
   e. from about 5 to about 8 percent of resin binder which can be dispersed in water and solvent systems;

and a refractory ring having a composition by weight consisting essentially of:
   f. from about 4.5 to about 5.5 percent low water content asbestos having a water content of about 3 to 6 percent;
   g. from about 4.5 to about 5.5 percent high water content asbestos having a water content of about 12 to 18 percent;
   h. from about 84 to about 87 percent sand; and
   i. from about 4.5 to about 6 percent of a resin binder which can be dispersed in water and solvent systems.

2. The combination of claim 1 further characterized by said low water content asbestos being amosite asbestos.

3. The combination of claim 1 further characterized by said high water content asbestos being chrysotile asbestos.

4. The combination of claim 1 further characterized by the low water content asbestos being amosite asbestos and the high water content asbestos being chrysotile asbestos.

5. The composition of claim 1 further characterized by the asbestos for the hot top liner composition being amosite asbestos.

6. The combination of claim 1 further characterized by the sand for the hot top liner composition having an A.F.S. grain fineness number of about 110.

7. The combination of claim 1 further characterized by the sand for the refractory ring composition having an A.F.S. grain fineness number of about 110.

8. The combination of claim 1 further characterized by the resin binder for the hot top liner composition and for the refractory ring composition being a phenolformaldehyde resin.

9. The combination of claim 1 further characterized by the wood flour being softwood flour in amount about 8 to 10 percent.

10. The combination of claim 1 further characterized by the wood flour being hardwood flour in amount about 10 to 11 percent.

11. The combination of claim 1 further characterized by the silica flour having particle size smaller than about 200 mesh.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,660,121 Dated May 2, 1972

Inventor(s) James F. McCarthy

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet in the ABSTRACT, line 1, "fiber" should read -- liner --. Column 2, line 5, "function" should read -- functions --; line 38, after "percent" insert -- low --. Column 5, line 24, "jointed" should read -- joined --.

Signed and sealed this 7th day of November 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.